Car sharing con veicoli elettrici: stima del mercato potenziale

Romeo Danielis, Lucia Rotaris, Eva Valeri

Dipartimento di Scienze Economiche, Aziendali, Matematiche e Statistiche,

Università degli Studi di Trieste, Italy

Abstract

The paper discusses the possibility of introducing a carsharing service in a tourist area to enhance the mobility alternatives available to tourists, to improve the accessibility to the tourist sites, to increase the location attractiveness and, in some instances, to preserve the quality of the environment. Such a possibility is already implemented in some locations. In order to evaluate the potential demand and the economic sustainability of such a service, which could be implemented both by private and public organization, a simulation model is presented and parameterized with data relative to Italy. The model allows testing which tariff and organizational structure is more convenient.

1 Introduction

Carsharing[1] is a model of car rental where a person rent a car for a short period of time, often by the hour. Cars are rented by an organization, such as commercial business, a public agency or a cooperative.

Historically, carsharing has started in Zurich, Switzerland, in 1948 in a community of people who thought that a car should not be a private possession but a "common" goods to be shared with others and owned by the commune, both for moral and economic reasons. Nowadays, even in Switzerland this "radical" spirit is much weaker and carsharing is a commercial enterprise, run by private or public organizations (the former are more common in North America, the latter in Europe, as one would expect) with the help of sophisticated technological booking and charging systems.

In the UK the term "carsharing" is often known as "car clubs", whereas the term "carsharing" is also used for carpooling or ride-sharing. However, strictly speaking, the terms "carpooling" or "ride-sharing" refer to the shared use of a private car for a specific journey, in particular for commuting to work, by people travel together to save on fuel costs. The term "car club" in the U.S.

[1] The term carsharing (earlier often written as two separate words, and still today occasionally hyphenated) is now the widely accepted international term.

refers instead to a club of car hobbyists. Since, the term carsharing is international gradually gaining currency it will be used throughout the paper.

It is also worth underlining that carsharing is different from traditional car rental service. The difference lies in its historical background and motivations and as well as in its organization. As for the motivations, carsharing is often motivated by social and environmental aims, as it will be discussed below, such as reducing car traffic, improving the modal split, reducing parking space needs, improving environmental quality while preserving flexibility and accessibility. With regards to the organizational aspects, carsharing differs from car rental since:

- Users are members and have been pre-approved to admitted to the program (background driving checks have been performed and a payment mechanism has been established);
- Reservation, pickup, and return is self-service;
- Vehicle locations are distributed throughout the service area, and often located for access by public transport;
- Carsharing is not limited by office hours;
- Vehicles can be rented by the minute, by the hour, as well as by the day;
- Insurance and fuel costs are always included in the rates;
- Vehicles are not always serviced after each use, although certain programs such as Car2Go continuously clean and fuel their fleet.

The literature on carsharing is growing rapidly. Some of it tracks the growth and expansion of carsharing (Shaheen et al. 1998, 2006, 2009; Shaheen and Cohen 2007). Other research focuses on administrative or logistical aspects of running a carsharing organization (Kek et al. 2009; Fan et al. 2008; Shaheen et al. 2003; Barth et al. 2003; Barth and Shaheen 2002). A number of important contribution study the actual usage of the carsharing vehicles (Morency et al. 2008) and how the adoption of carsharing impacts VKT and vehicle ownership (Cervero et al. 2007; Lane 2005; Cervero and Tsai 2004; Cervero 2003). It is generally concluded that carsharing organizations provide a net reduction in VKT (Shaheen et al. 2006).

A further stream of research have performed a detailed demographic analyses of those who have chosen to join a carsharing service (TCRP 2005, Burkhardt and Millard-Ball 2006). It is found the the propensity to use carsharing is higher in urban residential locations, with people who have a concern for environment, who have propensity to be an ‘‘early adopter’’, belonging to smaller households, with an high educational attainment, and in their 30s and 40s.

Other studies have investigated the familiarity with the concept of carsharing and willingness to accept it (Nobis 2006; Loose et al. 2006) with the aim to help carsharing agencies provide attractive fare structures, understand effective advertising strategies, and determine the best neighborhoods to locate their carsharing vehicles (Celsor and Millard-Ball 2007).

With regards to the market potential of carsharing from the current niche market to a much larger market, some discussion has been taking place.

The carsharing companies include in their promotional website a section, and sometimes also a software, that estimate the potential cost savings that one can achieve through carsharing based on the annual kilometers travelled (City Carshare 2010; Zipcar 2010, Milan carsharing, ICS). The ability of carsharing of providing financial cost savings is thought of as a decisive factor. However, although financial savings could be a interesting starting point, forecasting the potential demand for car sharing requires a much deeper understanding of which factors enter the decision making process between carsharing and car ownership and how, and how can these be applied to a specific area, with specific travel patterns, traffic conditions, traffic regulations and public transport supply.

In the scientific literature, an interesting application is provided by Schuster et al. (2005) who developed a complex simulation model that uses recorded travel patterns to predict the adoption of carsharing in Baltimore. They assumed for carsharing that the Flexcar program in use in the nearby Washington, D.C., metropolitan area in March 2004 would be adopted. It consists in an annual membership fee is of $25, an hourly rate of $9, and the mileage fee of $0.35. They estimate that carsharing would be chosen 1,474 out of 35,500 trials, or 4.15 ± 0.10% of the time. Such values would drop to 3.69 ± 0.09%, when it is taken into account that some people love expensive and prestige vehicles. Since such values are comparable to the area transit mode share, which was 5.7%, they conclude that carsharing may prove a useful part of an integrated strategy to reduce the negative effects of auto dependence.

Catalano et al. (2008) present a carsharing demand estimation for urban transport using stated preference techniques for the Italian city of Palermo. Estimating a nested logit model, they predict for carsharing a traffic share between 5-10%, compared to about 40% for the private car and about 30% for public transport.

Ciari et al (2009) discuss how a carsharing scheme should look like in order to grown from the current niche market to a large-scale scheme (defined as at least 5% of the relevant global fleet). They argue that such a scheme should be based on concepts such as the capillarity of the system, its flexibility and its integration with other urban mobility tools. They also stress the need for methodology which would be able to realistically assess carsharing market potential and suggests that the adoption of an agent based approach. As a framework to model such a large scale carsharing scheme they proposed to use MATSim-T, an existing agent based traffic micro-simulation tool (Ciari, 2010).

Ducan (2010) seeks to quantify the market potential of carsharing in the San Francisco Bay Area, defined as its ability to provide cost savings to those who adopt it in favor of vehicle ownership. The result is that a significant number (approximately more than a million people) of Bay Area households own a vehicle with a usage pattern that carsharing could accommodate at a lower cost. Such number is still a minority of the total number of car users in the Bay Area, but much larger than the current number of carsharing member across the entire US.

Despite this optimistic forecasts, the actual size of the carsharing market is still quite small, although it shows huge growth rates.

Burlando (2007) reports that in 2006 worldwide the total number of vehicles available for carsharing was equal to 11,696, two thirds of them located in Europe. The total number of carsharing member was equal to 347,910, with a ratio of 1 vehicle for every 30 members. More

recent estimates (Shaheen et al., 2009), report that, as of July 2008, the North American carsharing market had grown to 33 operators with 318,838 members and 7,505 vehicles collectively, that represents a threefold increase in membership and twofold increase in vehicles. Mobility, the Swiss carsharing organization state to have 2,600 vehicles in 1,300 location in Switzerland available. In Italy, ICS reports to have in September 2011, 599 vehicles in 404 parking places and 17,925 member, located in 12 Italian cities.

Although the growth rate is impressive, the absolute size of market is insignificant compared to the number of car circulating worldwide: consequently, carsharing is still a niche market. However, there is a great deal of discussion on the potential of carsharing, which is described an important innovation for mobility.

In the literature on carsharing various potential market segments have been identified and targeted such as residential neighborhoods, business communities, college students and low-income families (Shaheen et al., 2009). The focus of this paper is on tourism. Tourists represent an interesting target group because they visit locations which are far away from their hometown, often leaving their private car at home or without having the possibility of bringing their private car (when the location is too far away or in a different continent). However, they have stringent mobility needs: they often wish to visit as many locations as possible in as little time as possible in order to maximize the benefits of traveling. When the sites to visit are far apart and public transportation is not available with the necessary frequency and flexibility, the use of a car is very convenient.

When a tourist does not drive by his\her private car to the tourist destination, a car may be available as a taxi with a local taxi driver (in some cases rented even for an entire day), or via a car rental service, to be picked up at the airport or at the train station. The availability of a carsharing service is an additional possibility, with its own advantages and disadvantages. It can compete with the previous ones in terms of costs and flexibility depending on its cost structure and service organization and on the tourists' needs and characteristics, as we will discuss below.

A further aspect which needs to be stressed is that the existence of a carsharing service may be beneficial not only from the private point of view of the tourist but also from the one of the tourist location. As locations compete among each other to attract tourists, the availability of a carsharing services could enhance the attractiveness of a location. Tourist know that a wide array of mobility options are at their disposal and that the accessibility of all interesting sites is guaranteed with a effective mean of transportation. This may even influence their choice on how to reach a the location. If a carsharing service is available at the destination, driving their private car might be a discarded option in favor of flying or of riding a train.

Even more interestingly, if the tourist destination is environmentally sensitive, the carsharing services might consist in low- or zero-emission vehicles such as an electric car which provides very limited noise and zero pollution emissions when the car is used. In turn, ”green” cars might strengthen the attractiveness of the destination and be used as a marketing tool to signal a special attention to tourism sustainability. Mountain areas, parks or islands might even take a stronger

stance and prohibit the use of private cars unless they are not up to certain environmental standards.

2 Carsharing for tourists: some examples

Carsharing services aimed at tourists are already a reality in many places. A simple Google search conducted in June 2012 revealed these examples.

- Green car-sharing by the hour at Hawaii hotels - www.springwise.com/tourism_travel/greencarhawaii/ - United States 30th August 2010 in Automotive, Tourism & Travel. Hotels and car-sharing are a natural fit, as we've already seen in Zipcar's partnership with AKA.
- Car Sharing - Official website Milan Tourism www.turismo.milano.it. A Car Sharing service, managed by several societies operating in Milan, is available. This is an innovative service that allows you to choose your vehicle
- Car Sharing Vancouver | Vancouver Tourist. www.vancouvertourist.com/content/car-sharing-vancouver - Vancouver has 3 car sharing companies called car2go, ZipCar and Modo.
- Plan your route/ Car hire & CarSharing, Chur Tourismus, Hotel ... - www.churtourismus.ch/en/.../plan-your-route-car-hire-carsharing/ - CarSharing with Mobility is the clever way to be mobile. Mobility has 2300 vehicles at your disposal at 1150 stations throughout Switzerland. 24 hours a day
- Mobility - Car sharing - Themes - Nyon Region Tourism - www.nyon-tourisme.ch › Home › Topics - Car sharing is the clever way to be mobile. Whenever you want – without the commitments that owning your own car entails. Mobility has 2'500 vehicles waiting ..
- Travelling & Car Sharing Llanarmon - www.llanarmon.com/en/tourism-and.../travelling-car-sharing/ Home Tourism & Business Here. Travelling & Car Sharing

These examples prove that carsharing might be a useful addition to the services provided to tourist and a factor of attractiveness for the hotels or tourist locations that offer these services. But will the service be used? By how many and by which tourists? And what is their willingness to pay for the service? How is the service and the tariff structure going to be organized in order to be successful? Is the service going to the economically sustainable from a private a social point of view?

In order to answer these questions and to advise private firms or public agency on whether and how to organize the service, we believe that a simulation model might be a useful tool. Therefore, such a model and some numerical simulations will be presented below.

3 A simulation model

A simple simulation model to estimate the potential demand for a carsharing service by tourists is illustrated in figure 1.

The model is made up of three components.

The first component contains the socio-economic and context variable, such as the ones capturing:

- The socio-economic characteristics of the tourists: age, income, number of people travelling together, number of children travelling, and so on;
- The variables describing the trip that needs to be made between the town of residence and the tourism destination: distance, geographical characteristics (intra-continental, inter-continental, island), means of transport available, and so on;
- The trips describing the tourist destination: city, countryside, number of locations worth-visiting, means of transport available, and so on;

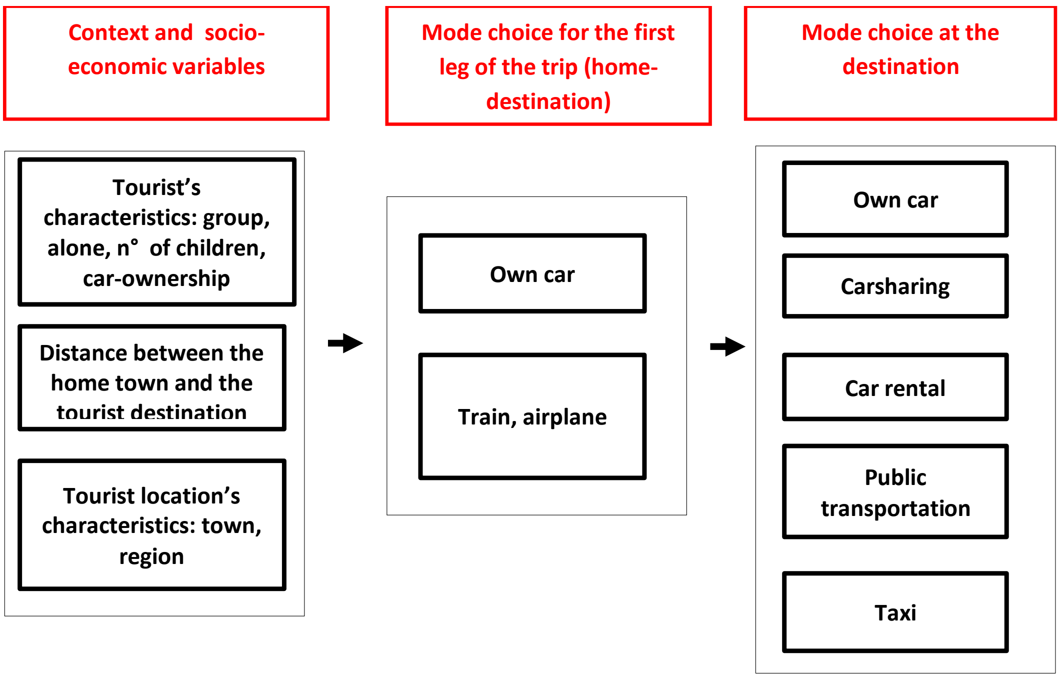

Figure 1 – Flow chart of the simulation model

The second component describes the transport choices available for the trip from the hometown to the tourist destination, that is the modes of transport available and their cost and time characteristics. We include also the car, assuming that the distance and geographical characteristic of the trip make it possible to use of the car.

The second component describes the transport choices available at the tourist destination to visit the various tourist sites of interest, that is the modes of transport available and their cost and time

characteristics. The private car, the taxi, carsharing, car rental and public transport are assumed available.

The next paragraph will present a numerical simulation assuming variables' parameters and specifications.

4 A numerical simulation

4.1 Assumptions

Let us assume that the socio-economic and context variables are the following.

- Distance between home and tourist destination: 500 km, 1000 km, which could be covered also by car transport.
- Type of destination: City, Region. The City is a metropolitan area with sites of interest spread in many urban and suburban locations (e.g., Rome). The Region (e.g., Sicily) contains several sites of interest at reasonable distance from the hotel where the tourists are lodged.
- Car ownership: Yes, No. The tourist might own or not own a private car.
- Number of people traveling: 1 (single), 3 (family)

Mobility at destination

Let us also assume the following holiday characteristics and mobility patterns at the tourist destination.

- Length of the holiday: 1 week
- N ° of days: 5
- Number of visits during the week: 7
- Distance in km from the hotel to sites visited: 2 km (in City), 30 km (in Region)
- Number of days of use of car rental during the week: 5
- Time needed for a visit: 4 h (in City), 6 h (in Region)

We provide now the list of the formulas used in the model and of the parameters' values assumed. The latter are as realistic as possible, considering the May 2012 prices in Italy. Whenever there is uncertainty or we wanted to perform sensitivity analysis a stochastic value is assumed and provided.

Route from home to destination

Auto costs = auto monetary cost + auto time cost

auto monetary cost = cost of petrol per km * km driven

cost of petrol = 0.2 €/km

cost of the time = travel time in hours * value of time

travel time in hours = 4 (for 500 km), 8 (for 1000 km)

Value of time: 5 €/h (normally distributed with standard deviation equal to 1). This value is based on the empirical literature which suggests a 20€/h value for the commuting trips. Since during holidays, there is less time pressure we assumed the 5 € value to be reasonable. Since relevant uncertainties, however, do exist and since the value of time might differ among tourist, a normal distribution of the value of time is assume with a standard deviation equal to 1. Similar stochastic values are assumed below when uncertainties exist and where sensitivity analysis for the variable is of interest.

Train costs = train monetary cost + train time cost

train monetary cost = train cost per km * km traveled by train

Train ticket = 0.1 €/km

train time cost = travel time in hours * value of time

travel time in hours = 5 (for 500 km), 10 (for 1000 km)

Air costs = air monetary cost + air time cost

air monetary cost = monetary cost of air ticket

monetary cost of ticket = 300 € (for 500 km), 350 € (for 1000 km)

air cost of the time = air travel time in hours * value of time

air travel time in hours = 3 (for 500 km), 4 (for 1000 km)

Carsharing

Total cost of carsharing = membership cost + journey cost + hourly cost + time cost to reach the carsharing pod

Membership cost = 5 €/week

journey cost = cost per kilometer*distance driven

Cost per km = 0.28 €/km (normally distributed with standard deviation equal to 0.05)

cost per hour = 0.375 €/h (normally distributed with standard deviation equal to 0.1)

time cost to reach the carsharing pod= time to reach the carsharing pod*value of time

time to reach the carsharing pod = 0.2 h

Private car

Total cost of private car use = fuel cost + private car parking costs

private car parking costs = hourly parking cost *parking time

hourly parking cost = 1 €/ h

Public transport

Total cost of public transport = ticket cost + cost of the extra-ticket waiting time at stops

Tickets cost € = 1.5 (in town), 3 € (in region)

cost of the extra-ticket waiting time at stops = extra waiting time at bus stops * value of time

extra waiting time at stops = 0.8 h (in City), 3 h (in Region) (normally distributed with standard deviation equal to 0.1)

Car rental

Total cost of car rental = Daily cost of car rental + fuel cost

daily cost of car rental = 47 €

Taxi

Total cost of taxi = Fixed rate + taxi cost per km

Fixed rate = 3.2 €

Cost per km = 1.03 €

4.2 Results

By running 100,000 simulations for the stochastic normally distributed variables and with the above reported parameters one gets the results illustrated in table 1.

Table 1 – Mode choice probability (percentages) for the first part of the trip (hometown-tourist destination) and for the mobility at the destination, based on 100,000 simulative runs.

Distance	Desti-natio n	Auto Own.	N° pers.	Car only	Train + CS	Train + PT	Train + CR	Trai + taxi	Air + CS	Air + PT	Air + CR	Air + taxi
500	C	SI	1	0	99	1	0	0	0	0	0	0

500	R	SI	1	0	26	74	0	0	0	0	0	0
1000	C	SI	1	0	99	1	0	0	0	0	0	0
1000	R	SI	1	0	26	74	0	0	0	0	0	0
500	C	SI	3	100	0	0	0	0	0	0	0	0
500	R	SI	3	100	0	0	0	0	0	0	0	0
1000	C	SI	3	100	0	0	0	0	0	0	0	0
1000	R	SI	3	100	0	0	0	0	0	0	0	0
500	C	NO	1	0	99	1	0	0	0	0	0	0
500	R	NO	1	0	26	74	0	0	0	0	0	0
1000	C	NO	1	0	99	1	0	0	0	0	0	0
1000	R	NO	1	0	26	74	0	0	0	0	0	0
500	C	NO	3	0	99	1	0	0	0	0	0	0
500	R	NO	3	0	26	74	0	0	0	0	0	0
1000	C	NO	3	0	99	1	0	0	0	0	0	0
1000	R	NO	3	0	26	74	0	0	0	0	0	0

C=City, R=Region, CS=Carsharing, PT=Public transport, CR=Car rental

The following comments are in order.

If, as assumed, it is feasible to bring one's own private car at the tourist destination (provided one is an car owner), the use of the private car for all trips appears to be the best choice when a group of 3 persons travel together, both when the tourist destination is 500 or 1000 km away from the hometown. The opposite is true when one person travels on his\her own.

Quite surprisingly, carsharing appears to be 99% of the times the best choice when the tourist destination is a City, whereas only 26% of the times when the tourist destination is a Region. The reason has to do with the assumed carsharing cost structure. In a city, the trips are shorter, hence the distance and use costs are lower than the public transport costs, the latter suffering not so much from the ticket cost but from the extra-time assumed to be needed because of the its insufficient frequency and accessibility relative to carsharing. In a Region, on the contrary, the cost of the longer trips proved to be so expensive to counterbalance the frequency and accessibility insufficiencies of public transport.

Taxi and car rental appeared to be in all examined circumstance inferior choices.

Similarly, for the first leg, given the high cost of the air ticket, air is never the chosen alternative.

It is also of interest to perform a sensitivity analysis of the estimates provided in order to appreciate how the results depend on the various variables. Two interesting results are reported below.

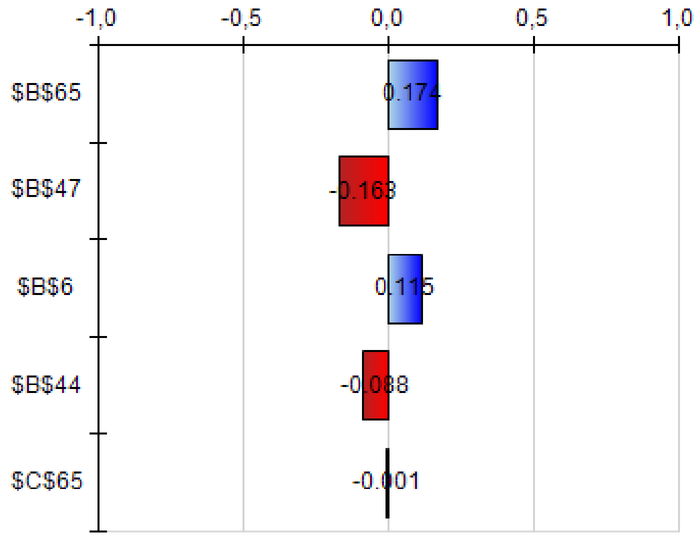

Figure 2 - Dependent variable: the probability of choosing the combination Train + Carsharing, when the tourist area is a City, 5oo km away from hometown. Independent variables by correlation importance: B65 – Public transport-extra-time in a city, B47 – Carsharing-hourly cost, B6 – Value of time, B44 – Carsharing-distance cost per km, C65 – Public transport-extra-time in a region

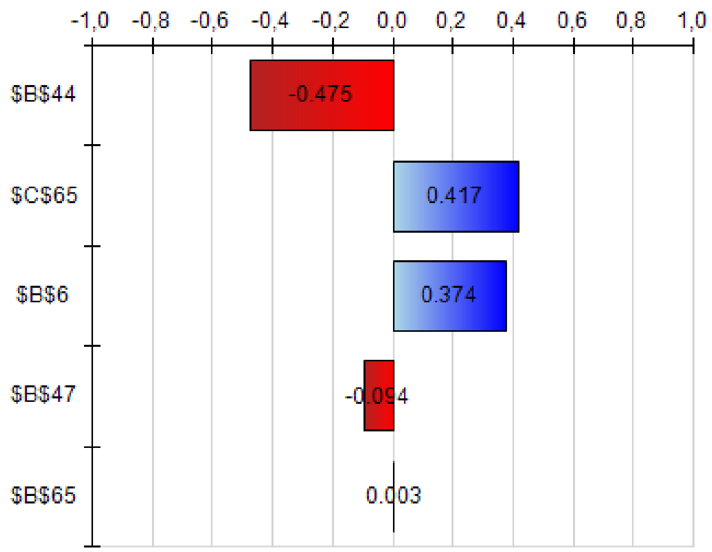

Figure 3 - Dependent variable: the probability of choosing the combination Train + Carsharing, when the tourist area is a Region, 5oo km away from hometown. Independent variables by correlation importance: B44 – Carsharing-distance cost per km, C65 – Public transport-extra-time in a region, B6 – Value of time, B47 – Carsharing-hourly cost, B65 – Public transport-extra-time in a city.

In figure 2, the dependent variable is the probability of choosing the combination Train + Carsharing, when the tourist area is a City, 5oo km away from hometown. Keeping all variable constant and changing one at the time the variables assumed stochastic, the figure reports the correlation between the dependent and independent variable. Both the sign and the size is of interest. The stochastic variable coded B65 – Public transport-extra-time in a city results negative

(as expected) correlated with the highest correlation level, followed by the variables B47 – Carsharing-hourly cost, B6 – Value of time, B44 – Carsharing-distance cost per km, C65 – Public transport-extra-time in a region.

On the contrary, in figure 3, the dependent variable is the probability of choosing the combination Train + Carsharing, when the tourist area is a Region, 5oo km away from hometown. The stochastic variable coded B44 – Carsharing-distance cost per km results negative (as expected) correlated with the highest correlation level, C65 – Public transport-extra-time in a region, B6 – Value of time, B47 – Carsharing-hourly cost, B65 – Public transport-extra-time in a city.

The less predictable result is the one relative to the value of time: the higher the more likely the tourist would use carsharing. Most probably, high income, busy tourists are the most likely users and benefiters of a carsharing service. Unfortunately, time pressure seems to be a feature of modern tourism.

5 Conclusions

The paper discussed the possibility of introducing a carsharing service in a tourist area to enhance the mobility alternatives available to tourists, the improve the accessibility to the sites of interest, to increase the location attractiveness and, in some instances, to preserve the quality of the environment. We showed that such a possibility is already implemented in some locations.

In order to evaluate the potential demand and the economic sustainability of such a service, which could be implemented both by private and public organizations, a simulation model might be quite useful to implement the service with the most convenient tariff and organizational structure.

A generic simulation model is then presented and parameterized with data relative to Italy and some results are derived. As the model is not specific to a city or a region, the results present no level of generality. However, the model implementation and the numerical simulations performed in this paper allowed us to structure the problem and to test which variables mostly affect the potential demand for carsharing by tourists.

For a full implementation of the model, we feel that the following steps would be needed:

- enhance the model with additional quantitative and qualitative variables (the latter estimated in monetary terms);
- describe with greater detail and differentiation the socio-economic and context variables;
- apply the model to a specific case study;
- fit the continuous or discrete stochastic variables with values coherent with the specific case study.

The above steps would allow to develop a useful decision support system for private or public decision makers.

References

AAA: Your Driving Costs. AAA Association Communication, Heathrow, FL (2010)

Barth, M., Shaheen, S.: Share-use vehicle systems: framework for classifying carsharing, station cars, and combined approaches. Transp. Res. Rec. 1791, 105–112 (2002)

Barth, M., Todd, M., Shaheen, S.: Intelligent transportation technology elements and operational methodologies for shared-use vehicle systems. Transp. Res. Rec. 1841, 99–108 (2003)

Barth, M., Li, W., Todd, M.: Interoperability options for shared-use vehicle systems. Transp. Res. Rec. 1887, 128–136 (2004)

Beatley, T.: Green Urbanism: Learning from European Cities. Island Press, Washington, DC (2000)

Burkhardt, J., Millard-Ball, A.: Who is attracted to carsharing? Transp. Res. Rec. 1986, 98–106 (2006) California Air Resources Board: Estimation of Average Lifetime Vehicle Miles of Travel. ttp://www.arb.ca.gov/regact/grnhsgas/vmt.pdf (2004). Accessed 1 May 2010

California DMV: Vehicle Registration Fee Calculator. https://mv.dmv.ca.gov/FeeCalculatorWeb/index.jsp (2010). Accessed 1 May 2010

Carsharing Network. http://www.carsharing.net/ (2009). Accessed 1 May 2010

Catalano, M., Lo Casto, B., Migliore M. (2008) - Car sharing demand estimation and urban transport demand modelling using stated preference techniques, European Transport \ Trasporti Europei n. 40: 33-50

Celsor, C., Millard-Ball, A.: Where does carsharing work?: Using geographic information systems to assess market potential. Transp. Res. Rec. 1992, 61–69 (2007)

Cervero, R.: City Carshare: first-year travel demand impacts. Transp. Res. Rec. 1839, 159–166 (2003)

Cervero, R., Landis, J.: Twenty years of the Bay Area rapid transit system: land use and development impacts. Transp. Res. A 31, 309–333 (1997)

Cervero, R., Tsai, Y.: City Carshare in San Francisco, California: second-year travel demand and car ownership impacts. Transp. Res. Rec. 1897, 117–127 (2004)

Cervero, R., Golub, A., Nee, B.: City Carshare: longer-term travel demand and car ownership impacts. Transp. Res. Rec. 1992, 70–80 (2007)

City CarShare: Rates and Savings. http://www.citycarshare.org/ratesandsavings.do (2010). Accessed 1 May 2010

Enoch, M., Taylor, J.: A worldwide review of support mechanisms for car clubs. Transp. Policy 13, 434–443 (2006)

Fan, W., Machemehl, R., Lownes, N.: Carsharing: dynamic decision-making problem for vehicle allocation. Transp. Res. Rec. 2063, 97–104 (2008)

Fellows, N., Pitfield, D.: An economic and operational evaluation of urban car-sharing. Transp. Res. D 5, 1–10 (2000)

Glaeser, E., Kahn, M.: The Greeness of Cities: Carbon Dioxide Emissions and Urban Development. National Bureau of Economic Research, Working Paper 14238 (2008)

Goldman, T., Gorham, R.: Sustainable urban transport: four innovative directions. Technol. Soc. 28, 261–273 (2006)

Huwer, U.: Public transport and car-sharing: benefits and effects of combined services. Transp. Policy 11, 77–87 (2004)

Katsev, R.: Car sharing: a new approach to urban transportation problems. Anal. Soc. Issues Public Policy 3, 65–86 (2003)

Kek, A., Cheu, R., Meng, Q., Fung, C.: A decision support system for vehicle relocation operations in carsharing systems. Transp. Res. E 45, 149–158 (2009)

Lane, C.: PhillyCarShare: first-year social and mobility impacts of carsharing in Philadelphia, Pennsylvania. Transp. Res. Rec. 1927, 158–166 (2005)
Litman, T.: Evaluating carsharing benefits. Transp. Res. Rec. 1702, 31–35 (2000)
Loose, W., Mohr, M., Nobis, C.: Assessment of the future development of car sharing in Germany and related opportunities. Transp. Rev. 26, 365–382 (2006)
Morency, C., Trepanier, M., Martin, B.: Object-oriented analysis of carsharing system. Transp. Res. Rec. 2063, 105–112 (2008)
MTC: Travel Demand Models for the San Francisco Bay Area (BAYCAST-90) Technical Summary. Metropolitan Transportation Commission, Oakland, CA (1997)
Murphy, J., Delucchi, J.: A review of the literature on the social cost of motor-vehicle use in the United States. J. Transp. Stat. 1, 15–43 (1998)
Nobis, C.: Carsharing as key contribution to multimodel and sustainable mobility behavior: carsharing in Germany. Transp. Res. Rec. 1986, 89–97 (2006)
Orski, K.: Car sharing. Transp. Q. 55, 13–15 (2001)
Parent, M.: New technologies for sustainable urban transportation in Europe. Transp. Res. Rec. 1986, 78–80 (2006)
Schuster, T., Byrne, J., Corbett, J., Schreuder, Y.: Assessing the potential extent of carsharing: a new method and its implication. Transp. Res. Rec. 1927, 174–181 (2005)
Shaheen, S.: Commuter-based carsharing: market niche potential. Transp. Res. Rec. 1760, 178–183 (2001)
Shaheen, S., Cohen, A.: Growth in worldwide carsharing: an international comparison. Transp. Res. Rec. 1992, 81–89 (2007)
Shaheen, S., Novick, L.: Framework for testing innovative transportation solutions: case study of CarLink, a commuter carsharing program. Transp. Res. Rec. 1927, 149–157 (2005)
Shaheen, S., Sperling, D., Wagner, C.: Carsharing in Europe and North America: past, present and future. Transp. Q. 52, 35–52 (1998)
Shaheen, S., Meyn, M., Wipyewski, K.: U.S. shared-use vehicle survey findings on carsharing and station car growth: obstacles and opportunities. Transp. Res. Rec. 1841, 90–98 (2003)
Shaheen, S., Schwartz, A., Wipyewski, K.: Policy consideration for carsharing and station cars: monitoring growth, trends, and overall impacts. Transp. Res. Rec. 1897, 128–136 (2004)
Shaheen, S., Cohen, A., Roberts, J.: Carsharing in North America: market growth, current developments, and future potential. Transp. Res. Rec. 1986, 116–124 (2006)
Shaheen, S., Cohen, A., Chung, M.: North American carsharing: a ten-year retrospective. In: Transportation Research Board 88th Annual Meeting Compendium of Papers, Washington, DC (2009)
Small, K., Verhoef, E.: The Economics of Urban Transportation. Routledge, Abingdon (2007)
TCRP (Transit Cooperative Research Program): Car-Sharing: Where and How It Succeeds. TCRP Report 108, Washington, DC (2005)
Wachs, M., Taylor, B.: Can transportation strategies help meet the welfare challenge? J. Am. Plan. Assoc. 64, 15–17 (1998)
Ciari, F., Balmer, M., Axhausen, K. W. (2009) “Concepts for a large scale car-sharing system: Modeling and evaluation with an agent-based approach”, Transportation Research Board Annual Meeting 2009, Paper #09-1888.
Ciari, F., (2010) Estimation of Car-Sharing Demand Using an Activity-Based Microsimulation Approach: Model Discussion and Preliminary Results, Conference paper Swiss Transport Research Conference (STRC) 2010.
Millard-Ball, A., Murray G., Schureter, J., Fox, C., Burkhardt, J. (2005) Carsharing: Where and how it succeeds, TCRP Report, 108, TRB, Washington D.C.
Warburton, D., Nicol, C., Bredin, S.: Health benefits of physical activity: the evidence. Can. Med. Assoc. J. 174, 801–809 (2006)
Wright, C., Curtis, B.: Reshaping the motor car. Transp. Policy 12, 11–22 (2004)

Zipcar: Savings Calculator. http://www.zipcar.com/is-it/savings-calculator (2010).